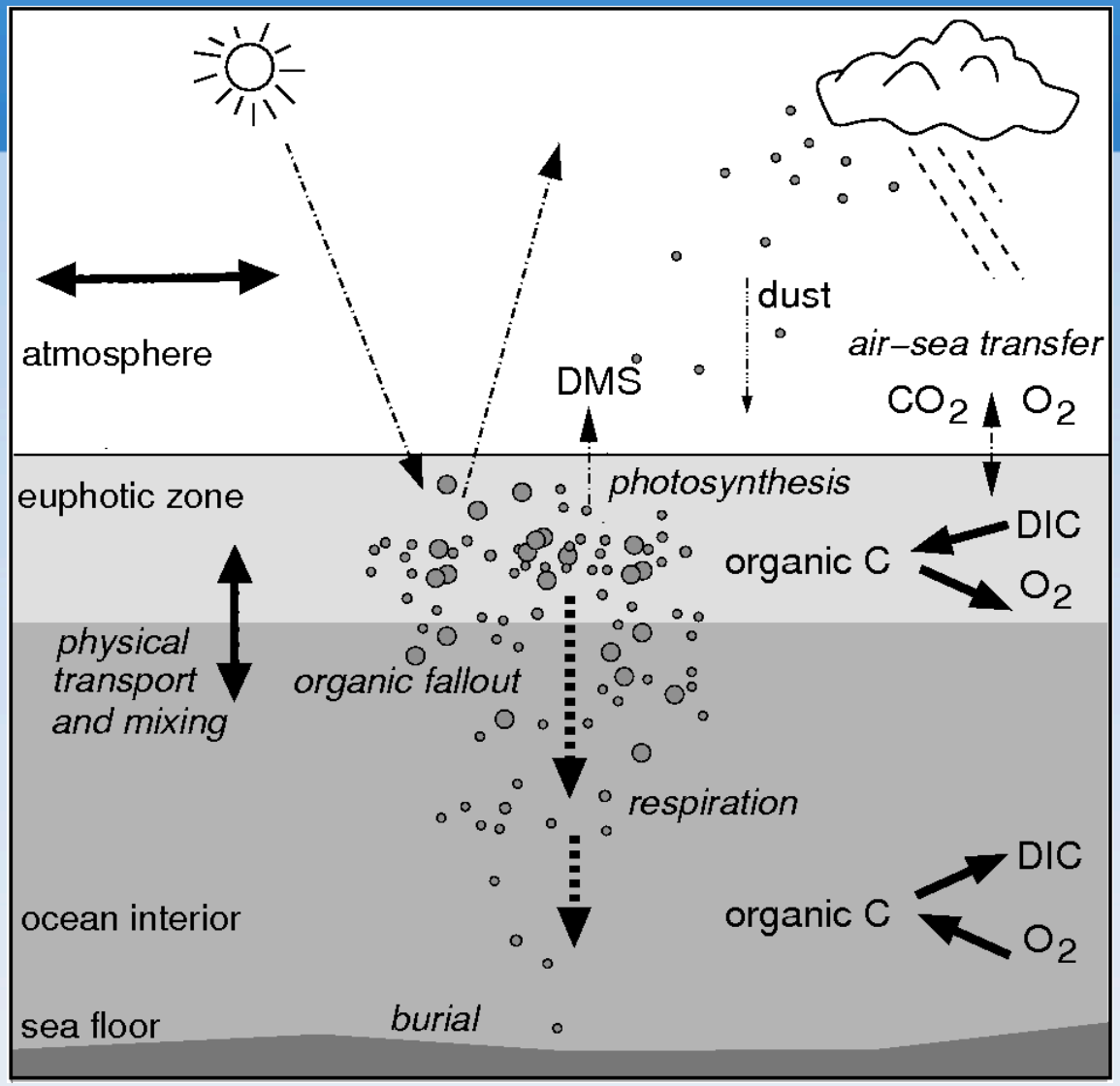
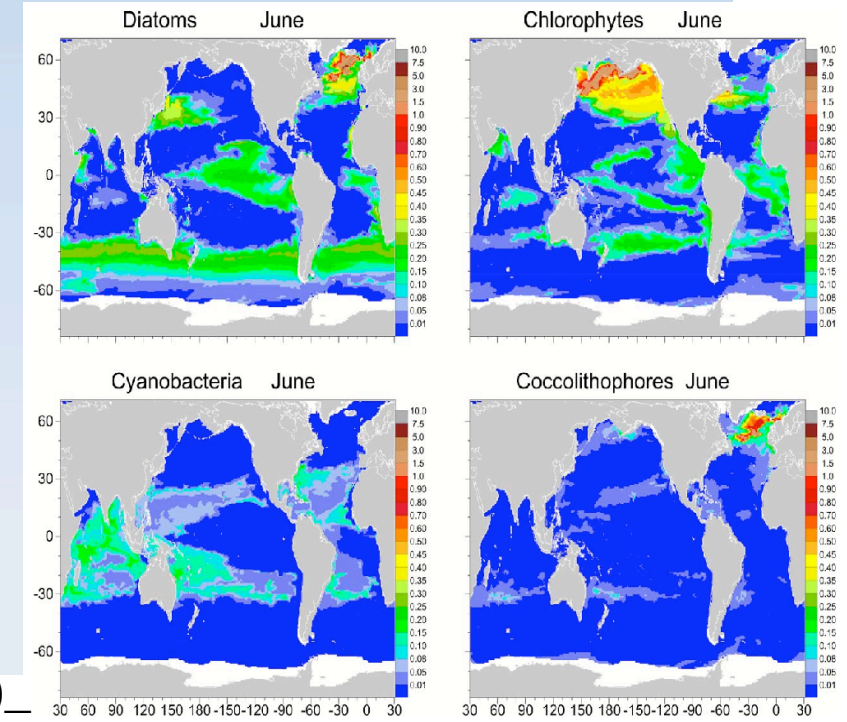
Climate Modeling: Ocean Biology and Biogeochemical Cycles



- How do climate and habitat changes influence productivity and elemental cycles of the global oceans?
- What are the standing stocks, transformation rates and fates of marine organic carbon pools, as well as inorganic particles?
- How do aerosols deposited on ocean surface influence nutrient levels and stressors for ecosystems?
- How do ocean biological processes influence aerosols and cloud distributions?

Current Ocean/Climate Biogeochemistry Models

- Coarse resolution
  - Dont resolve mesoscale/sub-mesoscale
  - Separate open ocean and coastal
- Begin to resolve functional groups of phytoplankton
- Typically ocean only; beginning to couple with climate models
- Data assimilation approaches in development (Chl-a)
- Typically simple RT model (PAR)_

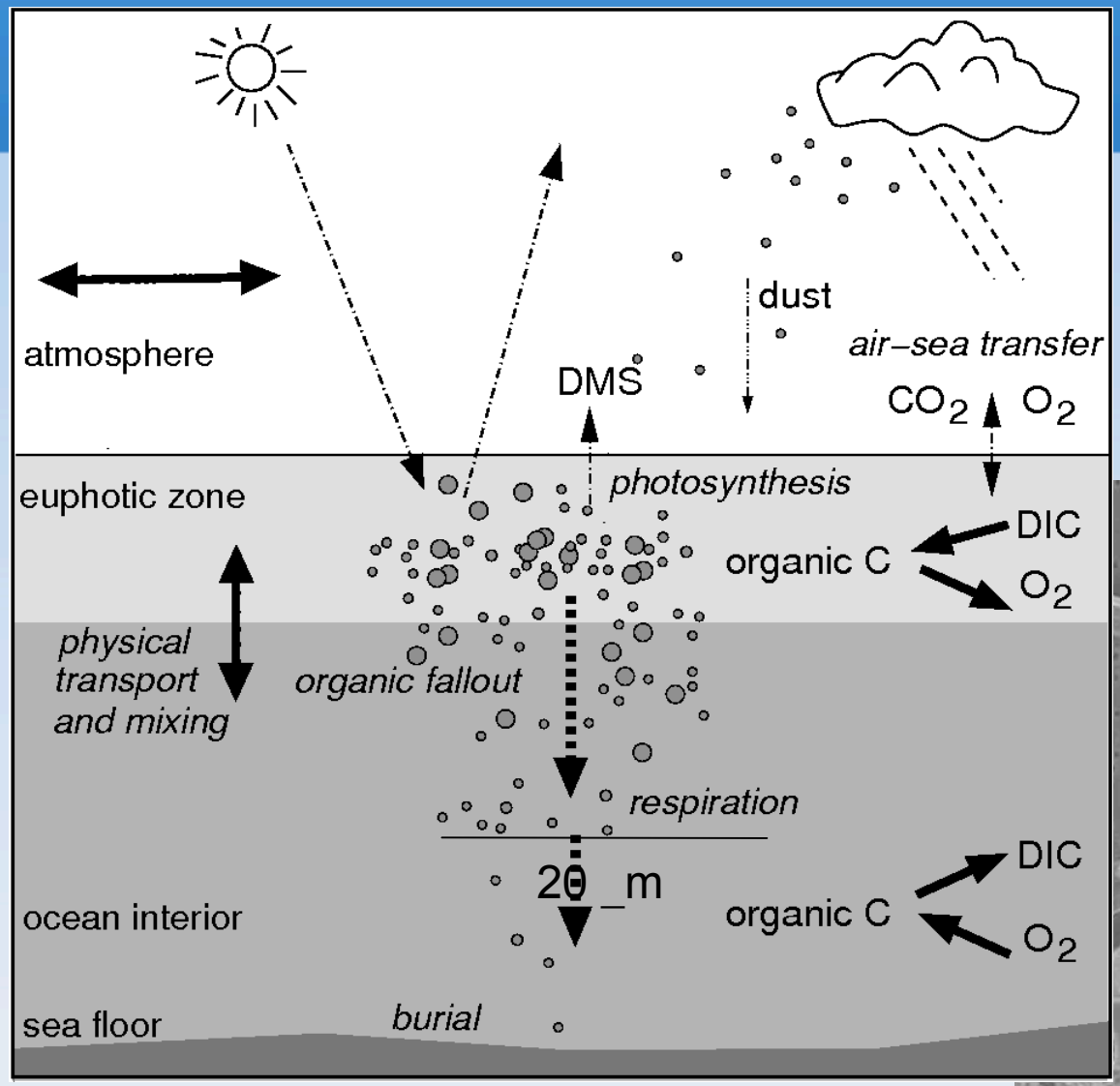


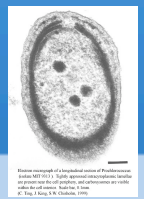
Gregg et al. (2003)_

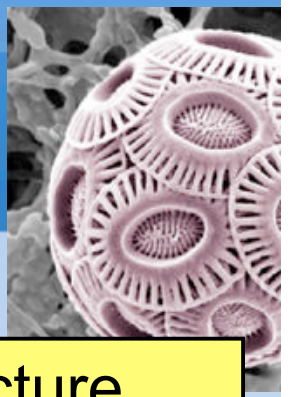
Ongoing/future developments

- **Computational advances will allow finer-scale resolution of environment & full coupling of climate system components**
  - fFine scale physical resolution
    - Resolve sub-mesoscale ocean features globally
    - Simultaneously resolve coastal and open ocean environments
  - Complex, “self-assembling” food web models
  - Fully coupled climate and biogeochemistry models
  - Application of mature data assimilation technologies

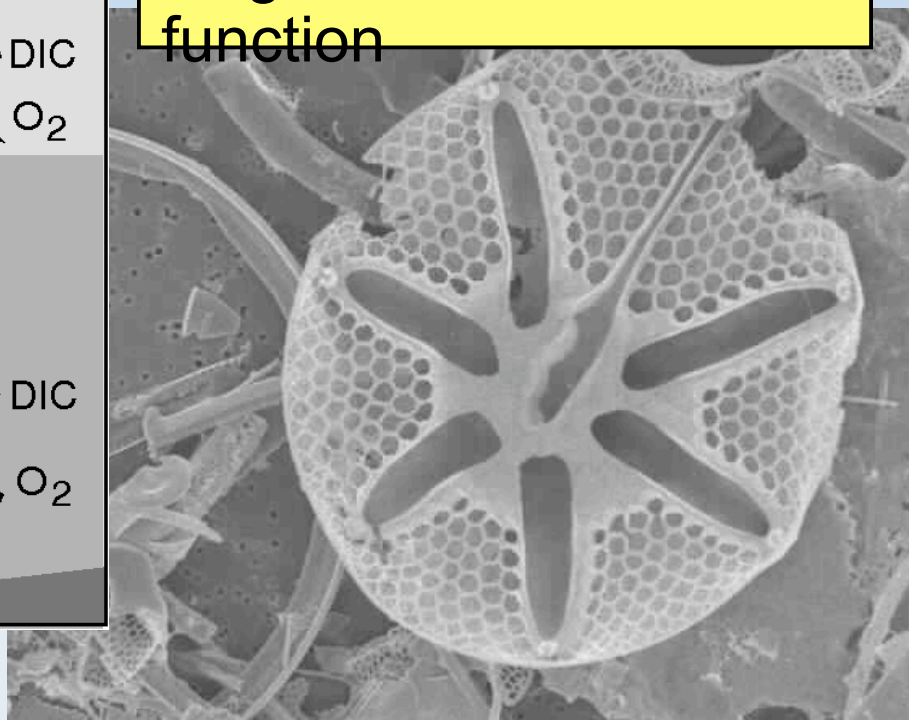
Ocean Biology and Biogeochemical Cycles







Community structure regulates export and biogeochemical function

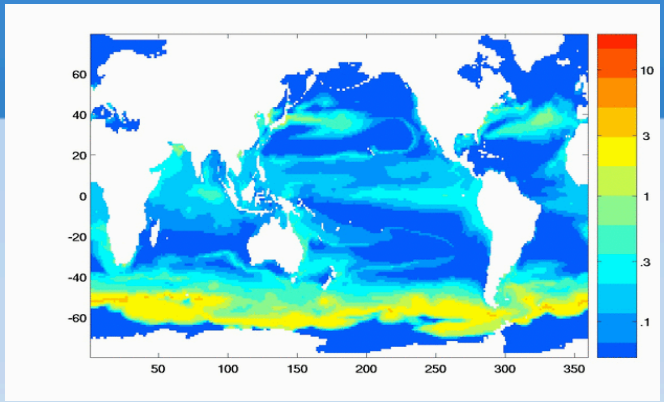


Marine ecosystem modeling: Near future...

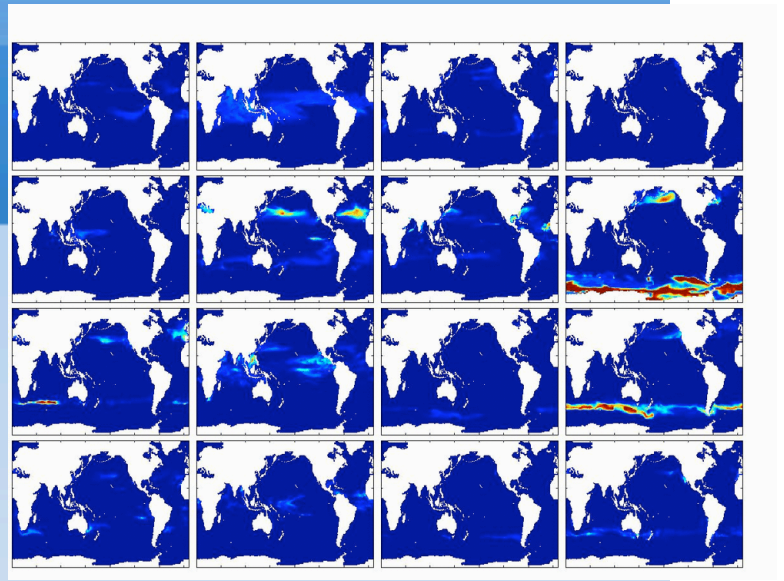
- **Finer resolution of ecosystem structure & function**
  - Multiple/many functional groups
  - Size structuring (optical and physiological impacts)_
  - Resolving food web (key for export)_
  - Explicit, spectral radiative transfer models
  - Suite of limiting nutrients & trace metals

Resolving functional groups of phytoplankton

MODELS

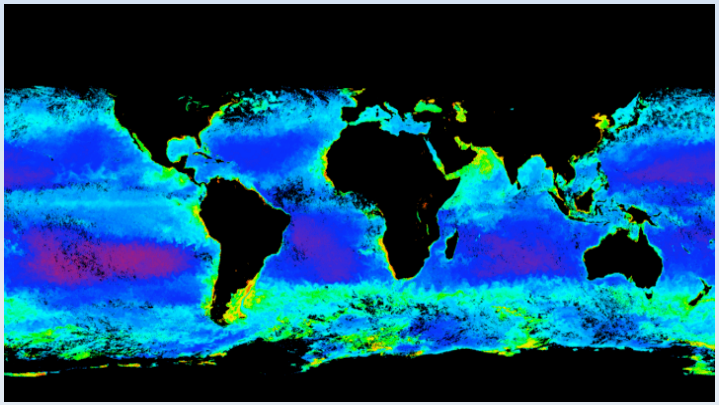


Modeled total biomass



Component functional groups
- different biogeochemical function

OBSERVATIONS

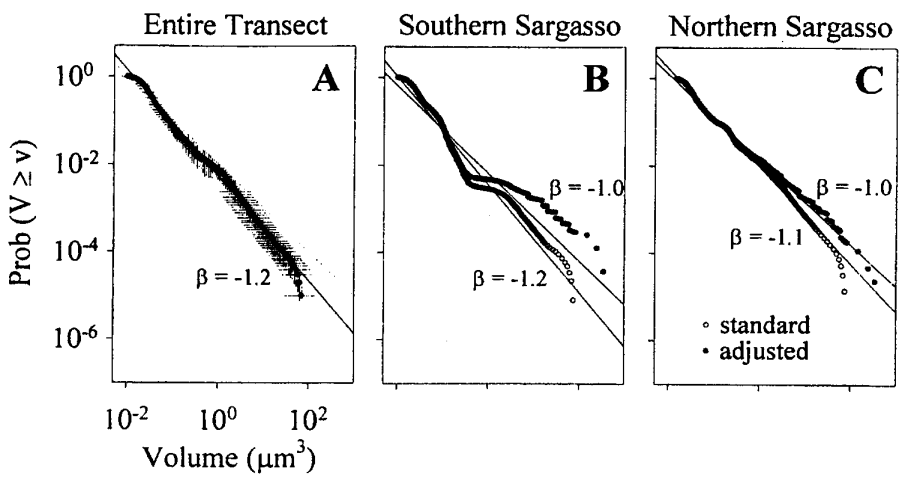


MODIS AQUA Chl-a, 2004

Size structure
functional groups
from Optical Property inverstions

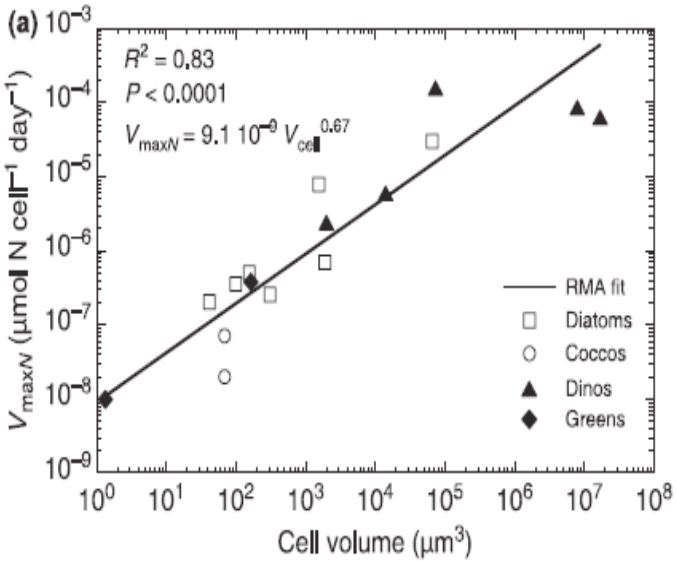
Size Structured Models

Cavendar-Bares et al (2001)_

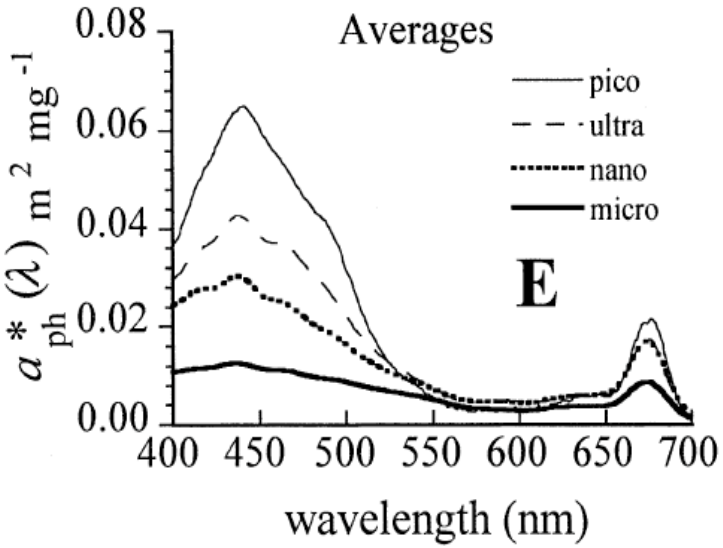


Structure in observed size distributions

Size dependence of physiological traits and optical properties



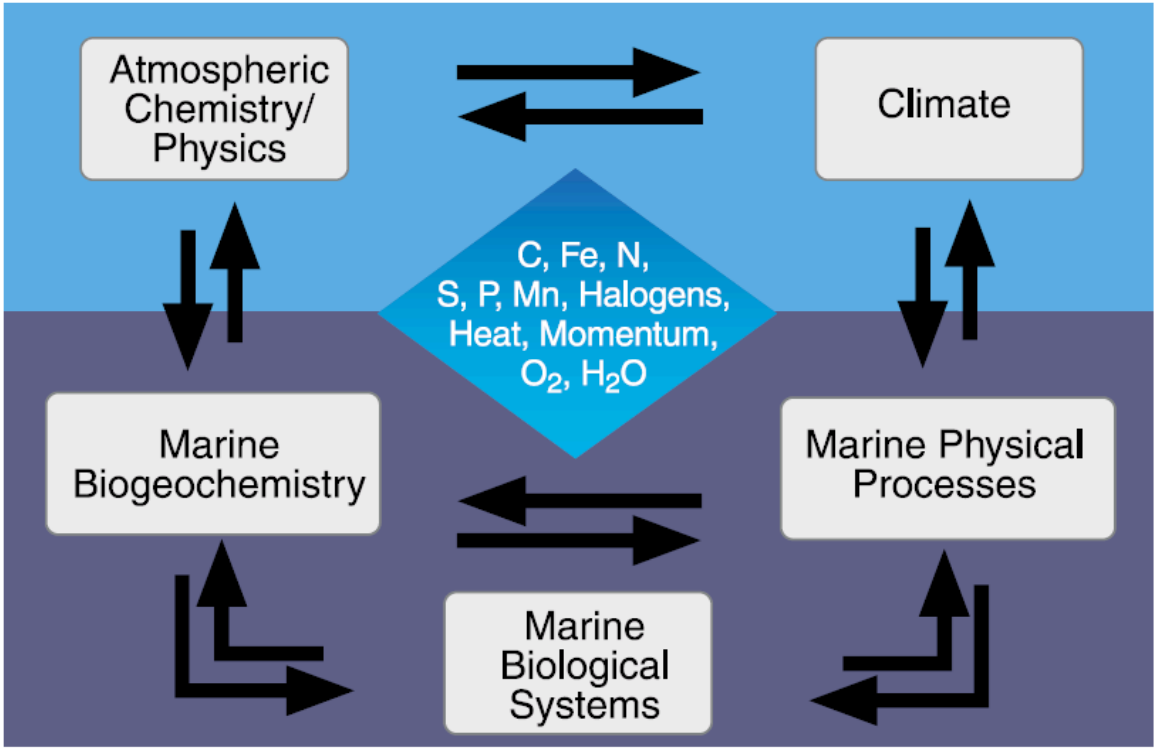
Litchman et al (2007)



Ciotti et al. (2002)

Ocean-atmosphere coupling

- Climate-ecosystem-biogeochemistry feedbacks
  - Aeolian trace metal & macro-nutrient sources
  - DMS – aerosol – clouds – climate
    - microbial physiology?
    - ???



Summary

- Marine ecosystem models will increasingly resolve food web structure and interactions
  - Observational resolution of phytoplankton functional types/ size structuring from jet-streak to global scale
- Increasing focus on “Earth System” models examining feedbacks in fully coupled system
  - Interdisciplinary modeling approaches and data sets
- Data assimilation for biological & biogeochemical models will mature significantly
  - Remote observations only means to provide sufficient spatial and temporal constraints (c.f. SST, SSH for phys ocean)_